Search for $K_L \rightarrow \pi^0\mu\mu$ in 1999 Data

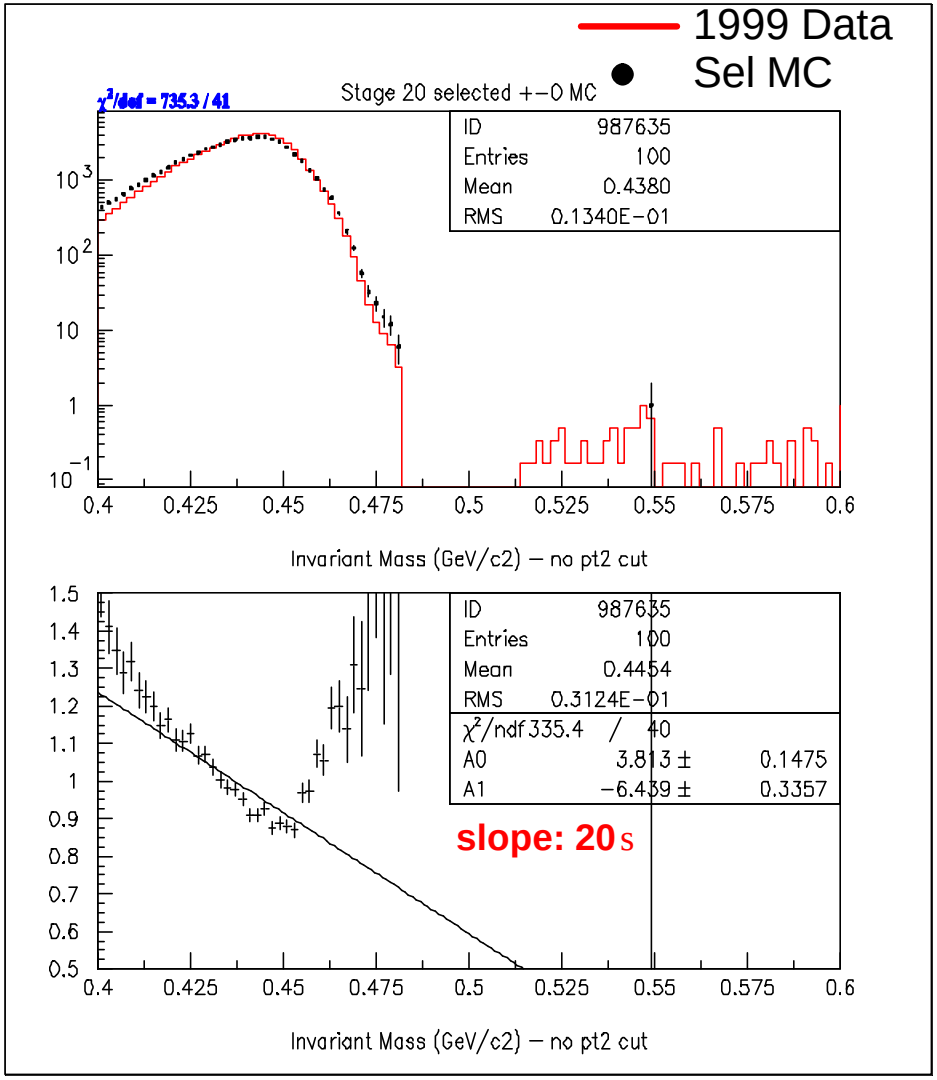
- Outline
  - Issues from last meeting
    - $KL \rightarrow \pi^0\mu\mu$ analysis
      - Backgrounds: $KL \rightarrow \pi^+\pi^-\pi^0$ MC
        - No forcing of decay or punch through – Select decay/punch-thru events at generator level - MC/Data mismatch
        - $KL \rightarrow \pi^+\pi^-\pi^0$ MC - No selection at generator level
  - Plans

Changes to KL→$\pi^+\pi^-\pi^0$ MC

- Implement the following changes to my v6.00 MC
  - ✓ Use Mike Wilking's magnet swim routines
    - MC/Data shoulder is gone
  - ✓ Generate MC selecting events with 2 pion decays, 2 punch throughs or 1 punch + 1 decay at Stage 20
    - MC/Data matching is poor
    - Absolute normalization is bad
    - Problem: Missing classes of events

1999 Data/Sel $K_L \rightarrow \pi^+\pi^-\pi^0$ MC

- Fit 1999 Data with "Selected" $K_L \rightarrow \pi^+\pi^-\pi^0$ MC, where I've selected events with 2 pion decays, 2 punch throughs or 1 punch + 1 decay
  - Floated MC in fit (normalization is wrong)
  - Shoulder from bad magnetic field modelling is gone, but shape is still wrong



No pt2 cut (remove evts in mass region)

$K_L \rightarrow \pi^+\pi^-\pi^0$ MC – no selection

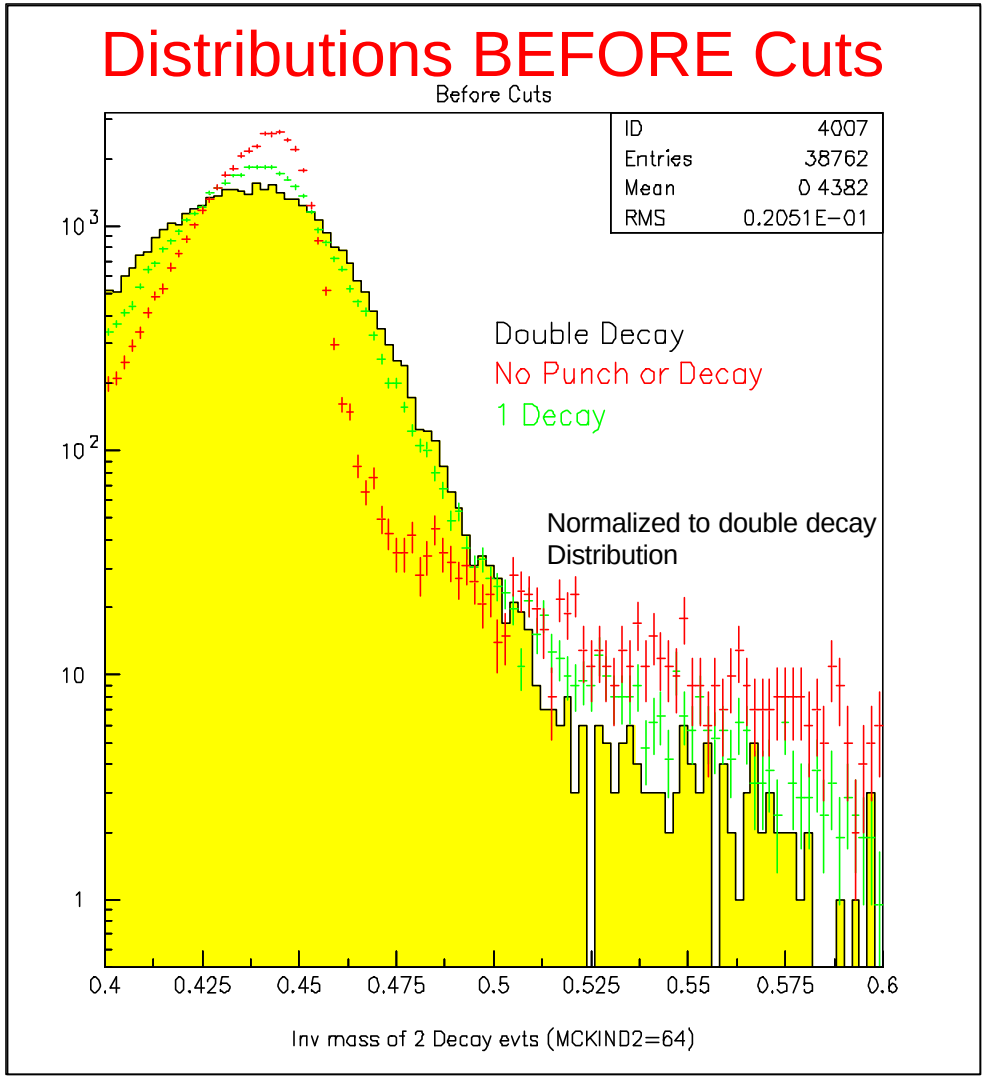
- What about accidental events that fire the muon banks?
  - 6 distinct classes of events
    1. 1 Decay + Accidental
    2. No decay or punch-thru
    3. 1 Punch-thru + Accidental
    4. 1 Decay + 1 Punch-thru
    5. 2 Decays
    6. 2 Punch-thrus
  - Run MC with no selection
    - Let KTEVMC $K_L \rightarrow \pi^+\pi^-\pi^0$ run normally
    - Select Trigger 5 Events ($K_L \rightarrow \pi^0\mu^+\mu^-$, $K_L \rightarrow \mu\mu\gamma\gamma$)
      - 2V * DC12 * 2MU3_LOOSE * PHVBAR1 * 2HCY_LOOSE * HCC_GE2
  - Move to the FARM – (thanks to SashaG)
    - Faster, but acceptance is small (~1.6%) so it is still slow
    - Only generated ~50% of 1999 data set (this talk: ~30%)

"Non-selected" $K_L \rightarrow \pi^+\pi^-\pi^0$ MC

	Output of MC	After all cuts except pt2&Mass	After all cuts except Mass
No Decay or Punch	23%	4%	10%
1 Punch	> 1 %	> 1%	> 1%
1 Decay	49%	20%	28%
1 Punch + 1 Decay	> 1%	> 1%	> 1%
2 Decays	28%	76%	62%
2 Punch	0%	0%	0%

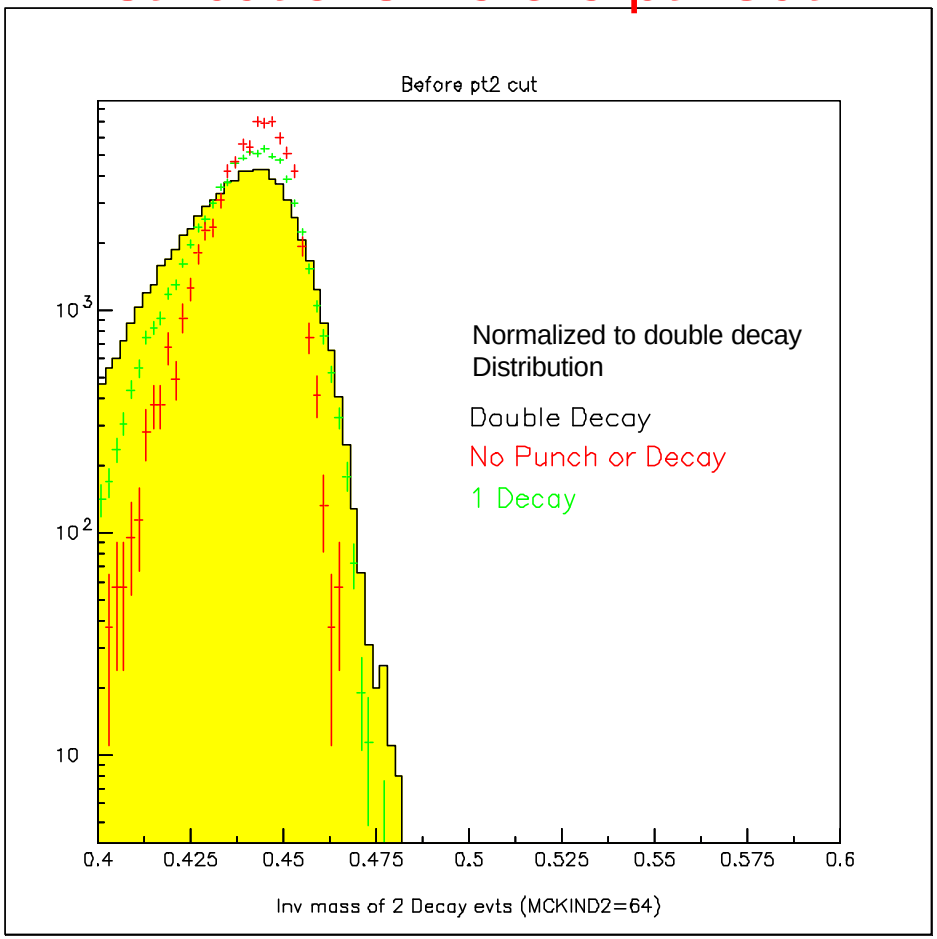
$K_L \rightarrow \pi^+\pi^-\pi^0$ MC Inv Mass Distributions

- New "non-selected" $K_L \rightarrow \pi^+\pi^-\pi^0$ MC has 3 major components after all cuts
  - Double Decay (62% after all cuts)
  - 1 Decay + Accidental (28% after all cuts)
  - No Decay or punch-thru (10% after all cuts)
- Inv Mass distributions for 3 major components are very different
  - Shapes more similar after pt^2 cut

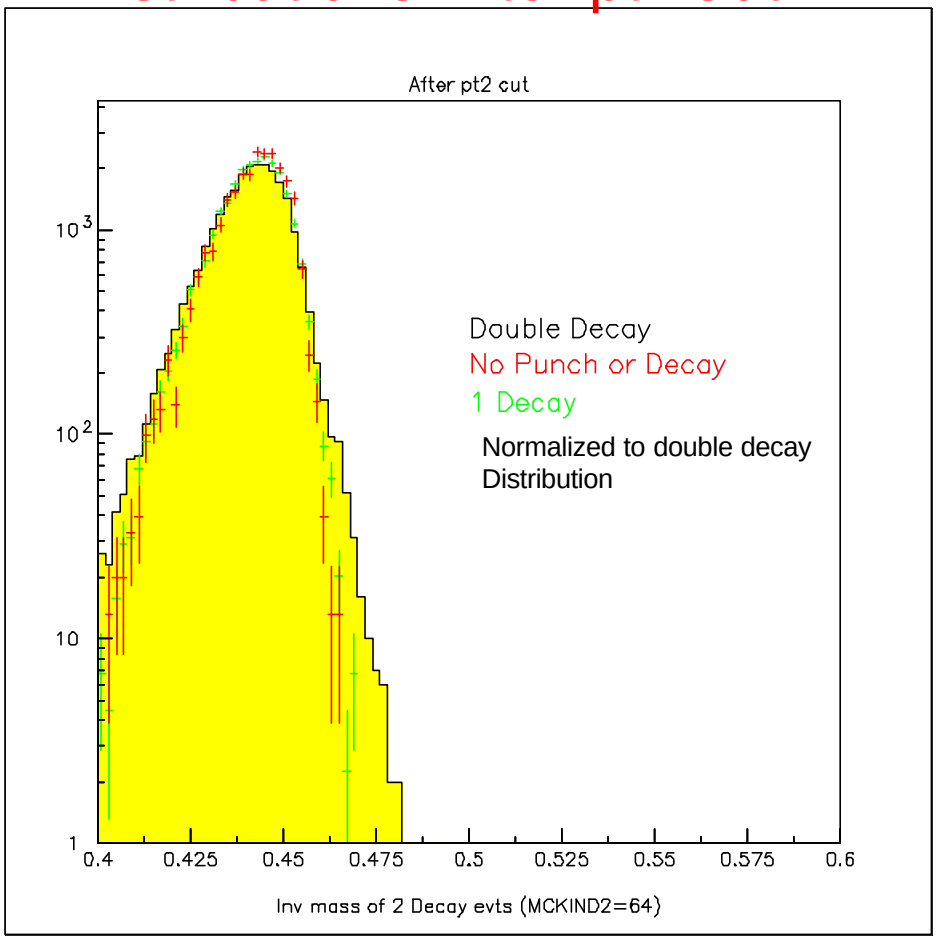


$K_L \rightarrow \pi^+\pi^-\pi^0$ MC Inv Mass Distributions

Distributions Before pt^2 Cut

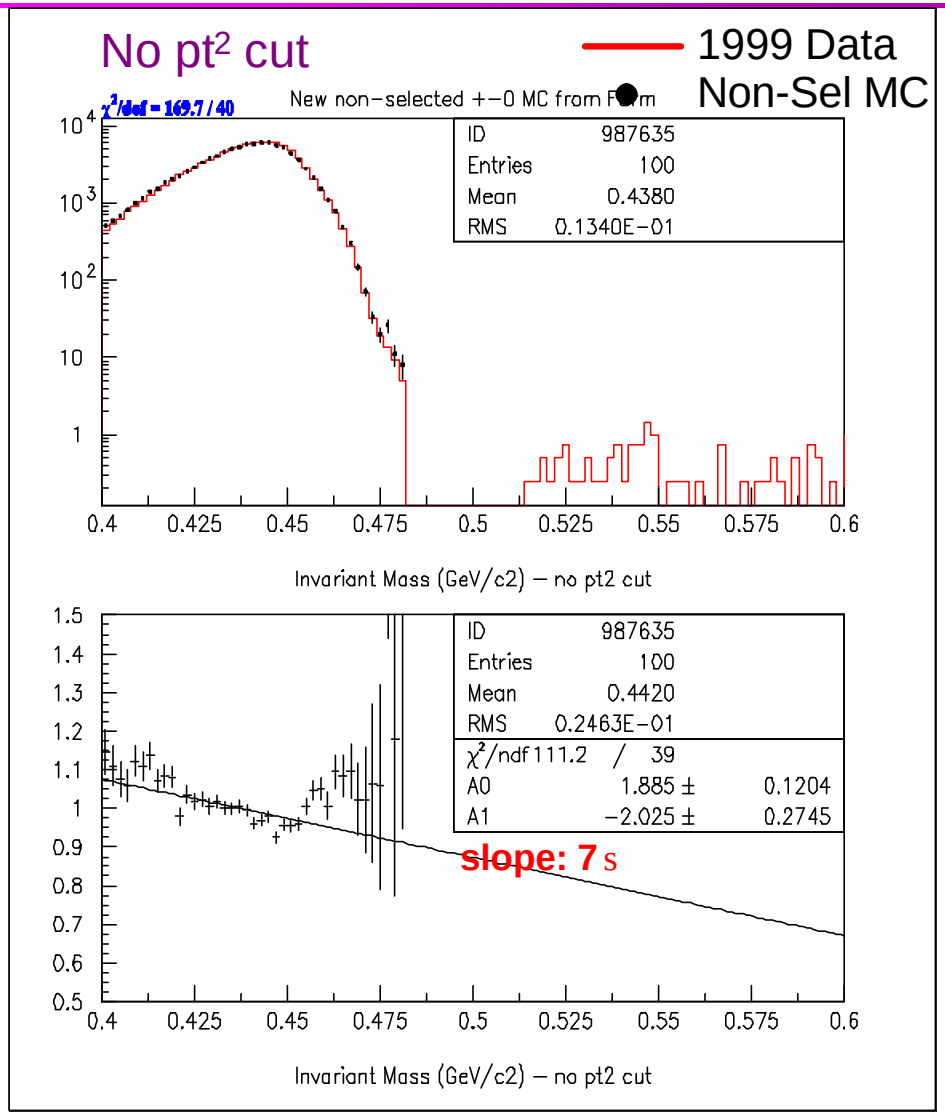


Distributions After pt^2 Cut



1999 Data/Non-Sel $K_L \rightarrow \pi^+\pi^-\pi^0$ MC

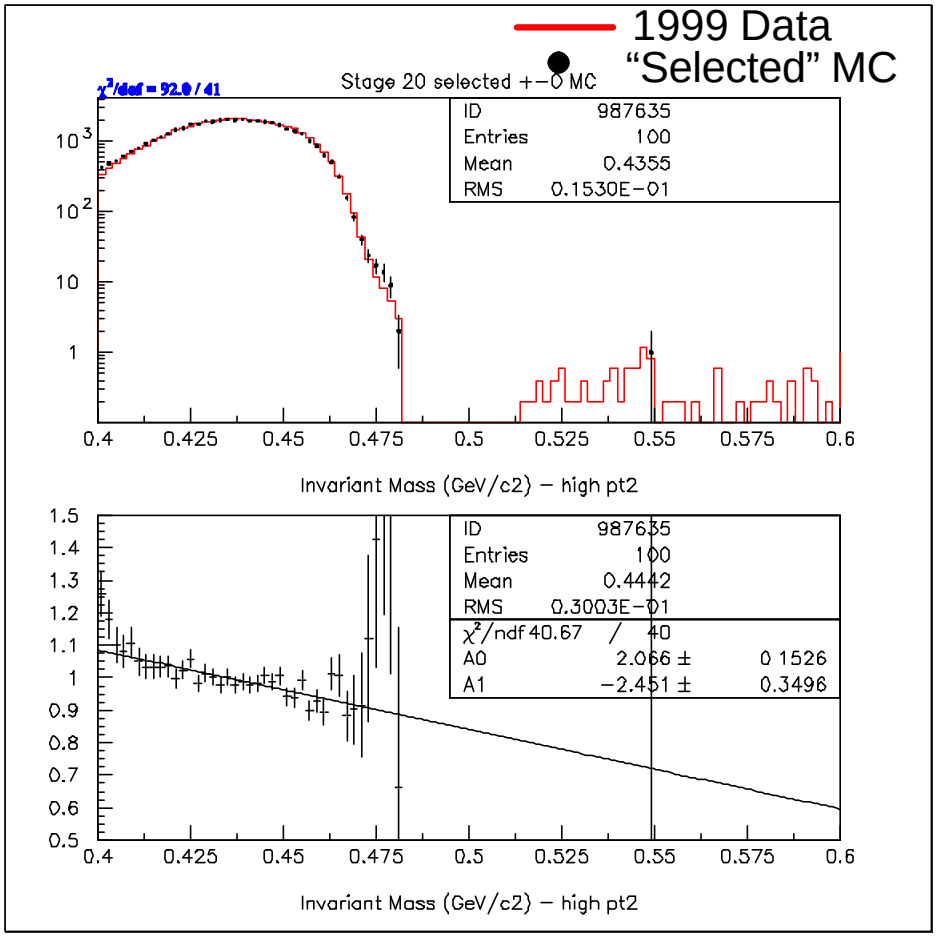
- Fit 1999 Data with "Non-Selected" $K_L \rightarrow \pi^+\pi^-\pi^0$ MC, where I have not selected off events with pion decays or punch through
  - Floated MC in fit
    - I've generated ~30% of 1999 data set. Normalization from fit ~25%.
    - Additional backgrounds from kμ3
  - Slope is better



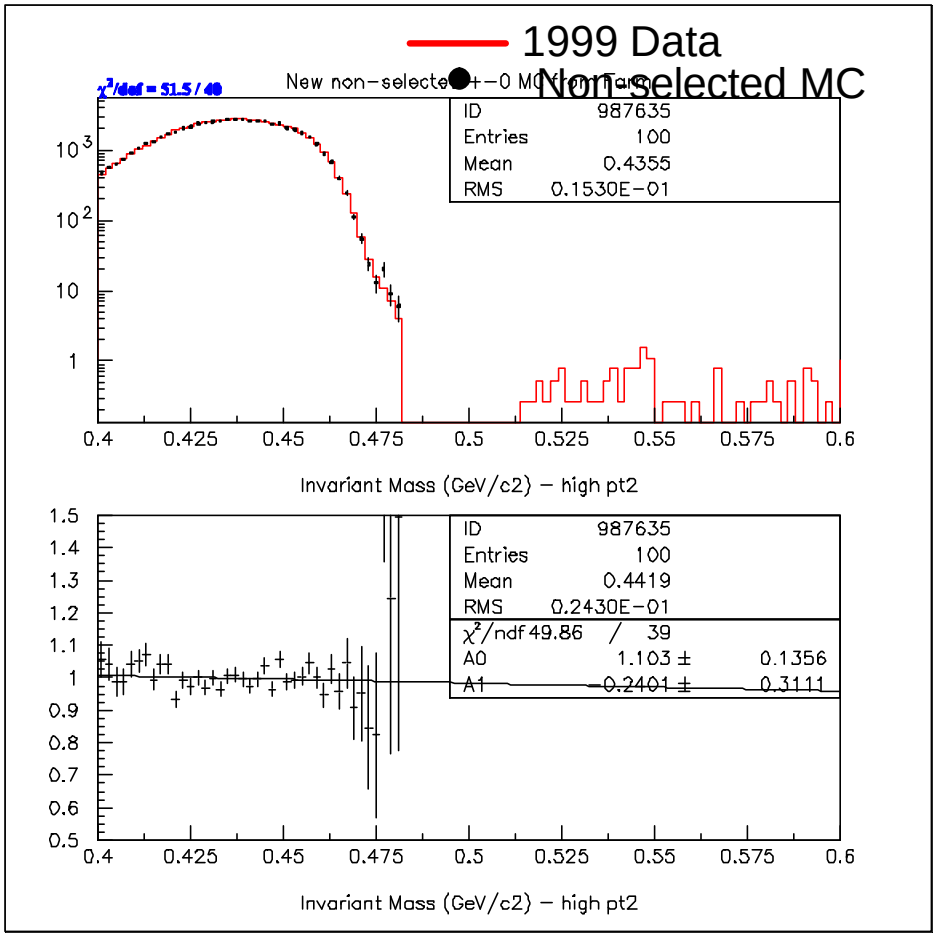
No pt2 cut (remove evts in mass region)

“Non-sel” v. “Sel” – high pt^2

Selected: 2 decay/2 punch/1 decay+ 1 punch

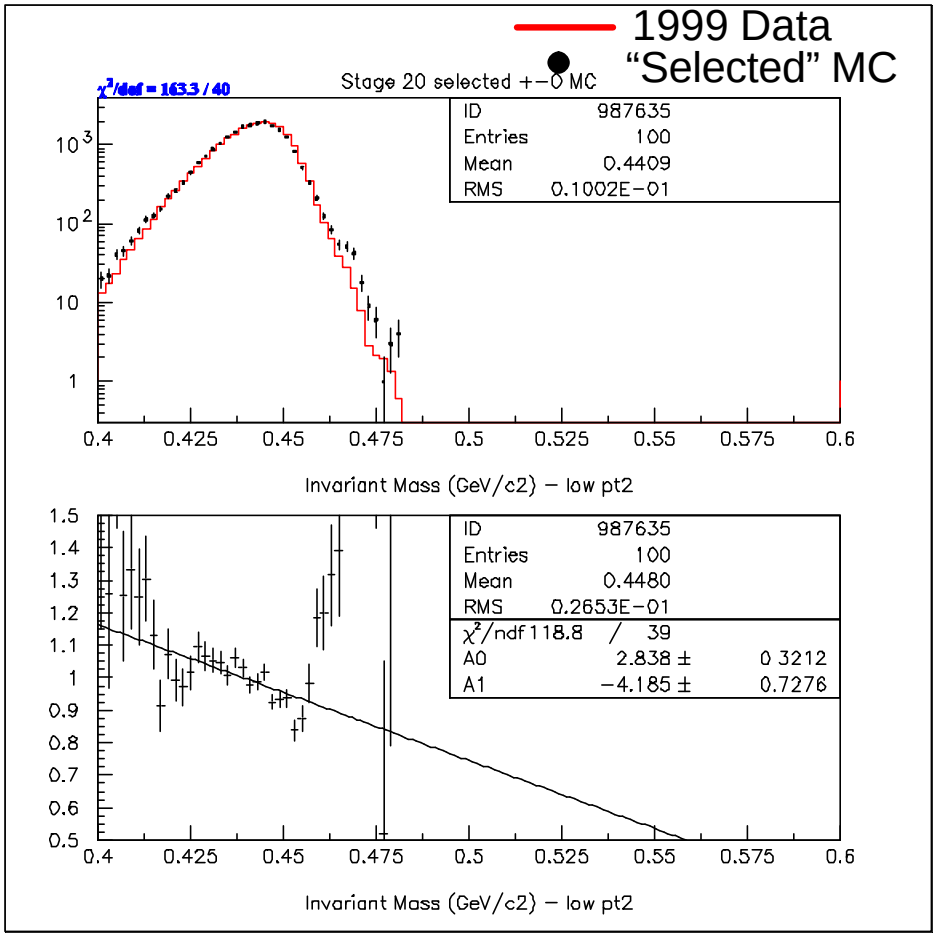


Non-selected MC

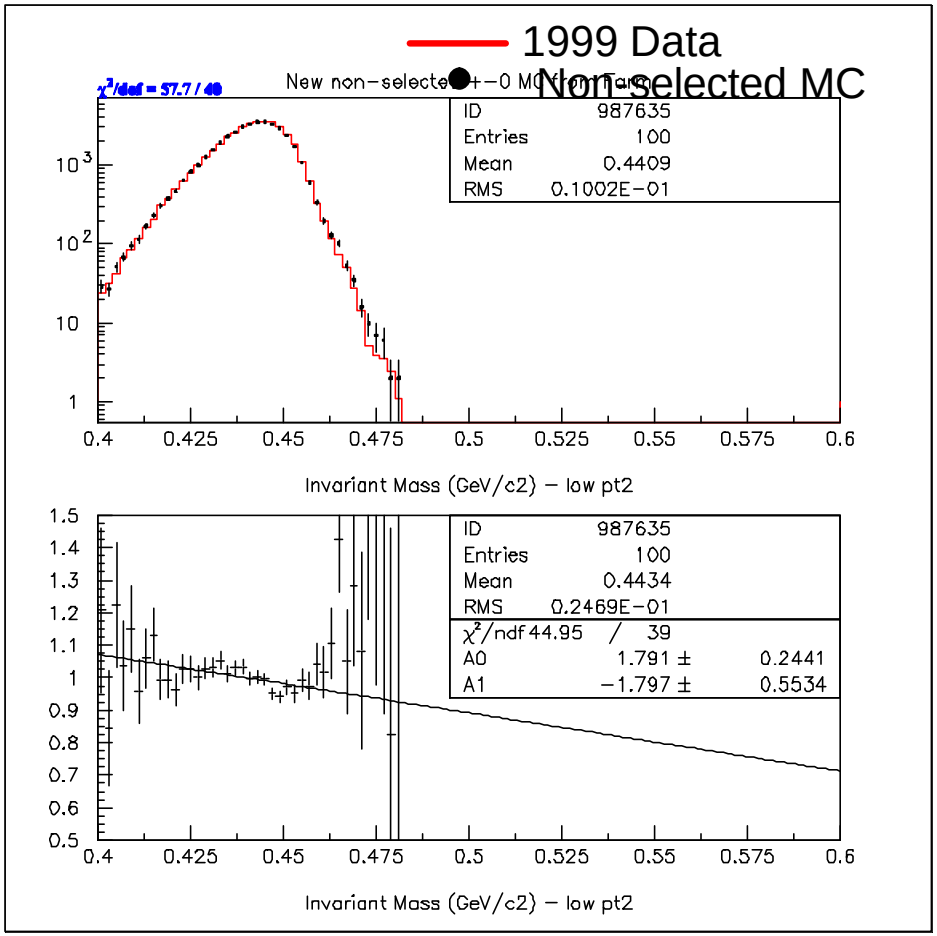


“Non-sel” v. “Sel” – low pt^2

Selected: 2 decay/2 punch/1 decay+ 1 punch



Non-selected MC



Current Issues

- $K_L \rightarrow \pi^+\pi^-\pi^0$ MC
  - I've only generated ~50% of the 1999 data set.
    - I overestimated the capacity of the farm.
    - Now that I know the classes of events in final sample, I could generated MC with "forced" pion decays and fix relative normalizations.
- $K_L \rightarrow \pi\mu\nu$ MC
  - I've stripped off accidentals with > 3 GeV in CsI
    - Speeds up generation by ~factor of 5
    - Possible problem: my L2 acceptances with >3GeV acc is 8.5% lower than with standard acc file
  - Start farm production with standard accidental libraries
    - Understand what is in my final sample
      - Kμ3 + decay + acc γs, kμ3 + acc μ+ acc γs

Plans

- Keep generating MC on farm – “No-selection” MC
  - $K_L \rightarrow \pi^+\pi^-\pi^0$: Do I need to skim off accidentals with muon hits?
  - $K_L \rightarrow \pi\mu\nu$: I’ll probably need to take short-cuts
    - Can I use the accidental library with >3GeV in CsI?
- Reduce background near box with additional cuts
  - Now that I have a relatively large MC data set, use it to study cuts
    - Extra DC hits from accidentals?
    - Neutral v. charged vertex cut?
    - Upstream/downstream track-angle cut?
    - Kinematic fit?